

CLAIMS

1. A method for providing an aggregate micro-flow, comprising the operations of:

defining a set of label switched paths;

5 defining a micro-flow comprising a set of data packets, the micro-flow having a quality of service type;

selecting a particular label switched path from the defined set of label switched paths based on the quality of service type of the micro-flow; and

transmitting the micro-flow along the selected label switched path.

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2. A method as recited in claim 1, further comprising the operation of determining a quality of service type supportable by label switched paths of the defined set of label switched paths.

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3. A method as recited in claim 2, wherein the selected label switched path is in a set of label switched paths capable of supporting the quality of service type of the micro-flow.

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4. A method as recited in claim 3, wherein the selected label switched path is utilized by fewer data packets than other label switched paths within the set of label switched paths capable of supporting the quality of service type of the micro-flow.

5. A method as recited in claim 1, further comprising the operation of determining a destination set of defined label switched paths capable of providing access to a destination address of the micro-flow.

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6. A method as recited in claim 5, further comprising the operation of determining a quality of service type supportable by label switched paths of the destination set of label switched paths.

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10 7. A method as recited in claim 6, wherein the selected label switched path is in a quality of service set of label switched paths capable of supporting the quality of service type of the micro-flow.

15 8. A method as recited in claim 7, wherein the selected label switched path is utilized by fewer data packets than other label switched paths within the quality of service set of label switched paths.

9. A method as recited in claim 1, wherein the quality of service of the micro-flow includes transmission rate information.

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10. A method as recited in claim 1, wherein the quality of service of the micro-flow includes delay variation information.

11. A micro-flow wrapper logical unit, comprising:

a predefined label switched path, the label switched path adapted to define a physical path along a set of network switches for transmission of a network data packet,
5 the label switched path capable of supporting a first quality of service type for data packets transmitted along the label switched path; and

a micro-flow comprising a plurality of data packets transmitted along the predefined label switched path, the micro-flow having a second quality of service type, wherein the first quality of service type is not a lower quality of service than the second
10 quality of service type.

12. A micro-flow wrapper logical unit as recited in claim 11, wherein the micro-flow includes a label that identifies the micro-flow.

15 13. A micro-flow wrapper logical unit as recited in claim 11, wherein the first and second quality of service type is selected from the set consisting of Available Rate Traffic, Maximum Rate Traffic, and Guaranteed Rate Traffic.

14. A micro-flow wrapper logical unit as recited in claim 11, wherein the
20 predefined label switched path is in a set of predefined label switched paths for a network.

15. A micro-flow wrapper logical unit as recited in claim 14, wherein the predefined label switched path is utilized by fewer data packets than other label switched paths in the set of predefined label switched paths.

5 16. A network switch for routing a micro-flow, comprising:
 a database including a predefined a set of label switched paths;
 an internal routing fabric capable of internally routing a micro-flow, wherein the micro-flow comprises a set of data packets, and wherein the micro-flow has a quality of service type;
10 logic that selects a particular label switched path from the defined set of label switched paths included in the database, the particular label switched path being selected based on the quality of service type of the micro-flow; and
 an egress line card capable of transmitting the micro-flow along the selected label switched path.

15 17. A network switch as recited in claim 16, further comprising logic for determining a quality of service type supportable by label switched paths of the defined set of label switched paths.

20 18. A network switch as recited in claim 17, wherein selected label switched path is in a set of label switched paths capable of supporting the quality of service type of the micro-flow.

19. A network switch as recited in claim 18, wherein the selected label switched path is utilized by fewer data packets than other label switched paths within the set of label switched paths capable of supporting the quality of service type of the micro-flow.

20. A network switch as recited in claim 16, further comprising logic that determines a destination set of defined label switched paths capable of providing access to a destination address of the micro-flow.

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21. A network switch as recited in claim 20, further comprising the operation of determining a quality of service type supportable by label switched paths of the destination set of label switched paths.

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22. A network switch as recited in claim 21, wherein the selected label switched path is in a quality of service set of label switched paths capable of supporting the quality of service type of the micro-flow.

23. A network switch as recited in claim 22, wherein the selected label switched path is utilized by fewer data packets than other label switched paths within the quality of service set of label switched paths.

24. A network switch as recited in claim 16, wherein the micro-flow has an associated forwarding equivalence class, the forwarding equivalence class defining additional transmission constraints for the micro-flow.

5 25. A network switch as recited in claim 24, wherein the selected label switched path is in a set of label switched paths conforming to the transmission constraints of the forwarding equivalence class.

10 26. A method for providing an aggregate micro-flow, comprising the operations of:

defining a set of label switched paths;
defining a micro-flow comprising a set of data packets;
selecting a particular label switched path from the defined set of label switched paths based on a utilization value of the particular label switched path; and
15 transmitting the micro-flow along the selected label switched path.

27. A method for providing an aggregate micro-flow as recited in claim 26, wherein the utilization value is an amount of data packets transmitted along the particular label switched path.

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28. A method for providing an aggregate micro-flow as recited in claim 27, further comprising the operation of recording an amount of data packets that are transmitted along each label switched path in the set of defined label switched paths.

5 29. A method for providing an aggregate micro-flow as recited in claim 28, wherein the amount of data packets that are transmitted along each label switched path in the set of defined label switched paths is recorded using a counter.

10 30. A method for providing an aggregate micro-flow as recited in claim 26, wherein the particular label switched path further is selected based on a destination value of the micro-flow.

15 31. A method for providing an aggregate micro-flow as recited in claim 26, wherein the micro-flow further includes a quality of service type.

32. A method for providing an aggregate micro-flow as recited in claim 31, wherein the quality of service type includes transmission rate information.

20 33. A method for providing an aggregate micro-flow as recited in claim 32, wherein the quality of service type includes delay variation information.

34. A network switch for routing a micro-flow, comprising:

storage including a predefined a set of label switched paths;

an internal routing fabric capable of internally routing a micro-flow, wherein the micro-flow comprises a set of data packets;

logic that selects a particular label switched path from the defined set of label switched paths included in the storage, the particular label switched path being selected based on the utilization value of the particular label switched path; and

an egress line card capable of transmitting the micro-flow along the selected label switched path.

10 35. A network switch for routing a micro-flow as recited in claim 34, wherein the utilization value is an amount of data packets transmitted along the particular label switched path.

15 36. A network switch for routing a micro-flow as recited in claim 35, further comprising logic that records an amount of data packets that are transmitted along each label switched path in the set of defined label switched paths.

20 37. A network switch for routing a micro-flow as recited in claim 36, wherein the logic that records the amount of data packets that are transmitted along each label switched path in the set of defined label switched paths is a counter.

38. A network switch for routing a micro-flow as recited in claim 34, wherein the particular label switched path further is selected based on a destination value of the micro-flow.

5 39. A network switch for routing a micro-flow as recited in claim 34, wherein the micro-flow further includes a quality of service type.

40. A network switch for routing a micro-flow as recited in claim 39, wherein the quality of service type includes transmission rate information.

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41. A network switch for routing a micro-flow as recited in claim 39, wherein the quality of service type includes delay variation information.

15 operations of:

receiving a first aggregate flow comprising a plurality of individual data flows, each individual data flow comprising a plurality of data packets;

separating the aggregate flow into a plurality of individual micro-flows, each individual micro-flow comprising a data flow;

20 routing the micro-flows to an egress switch;

creating a second aggregate flow comprising a set of micro-flows using the egress switch; and

transmitting the second aggregate flow.

43. A method as recited in claim 42, wherein the first aggregate flow is a label switched path.

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44. A method as recited in claim 43, wherein the second aggregate flow is a label switched path.

45. A method as recited in claim 42, wherein each micro-flow includes a
10 quality of service attribute.

46. A method as recited in claim 45, wherein each micro-flow is routed to the egress switch based on the quality of service attribute of the micro-flow.

15 47. A method as recited in claim 42, further comprising the operation of defining a set of label switched paths.

20 48. A method as recited in claim 47, further comprising the operation of determining a destination set of label switched paths capable of providing access to a destination address of the micro-flow.

49. A method as recited in claim 48, further comprising the operation of determining a quality of service type supportable by label switched paths of the destination set of label switched paths.

5 50. A method as recited in claim 49, wherein the selected label switched path is in a quality of service set of label switched paths capable of supporting the quality of service type of the micro-flow.

10 51. A method as recited in claim 42, wherein the quality of service of the micro-flow includes delay variation information.

52. A method for transmitting an aggregate micro-flow, comprising the operations of:

defining a set of label switched paths;

15 defining a micro-flow comprising a set of data packets, the micro-flow having a quality of service type;

determining the quality of service type supportable by label switched paths of the defined set of label switched paths;

20 selecting a particular label switched path from the defined set of label switched paths based on the quality of service type of the micro-flow; and

transmitting the micro-flow along the selected label switched path.

53. A method for transmitting an aggregate micro-flow, comprising the operations of:

defining a set of label switched paths;

defining a micro-flow comprising a set of data packets, the micro-flow having a

5 quality of service type that includes transmission rate information;

determining the quality of service type supportable by label switched paths of the defined set of label switched paths;

selecting a particular label switched path from the defined set of label switched paths based on the quality of service type of the micro-flow; and

10 transmitting the micro-flow along the selected label switched path.

54. A micro-flow wrapper logical unit, comprising:

a predefined label switched path, the label switched path adapted to define a physical path along a set of network switches for transmission of a network data packet,

15 the label switched path capable of supporting a first quality of service type for data packets transmitted along the label switched path; and

a micro-flow comprising a plurality of data packets transmitted along the predefined label switched path, the micro-flow having a second quality of service type selected from a set consisting of Available Rate Traffic, Maximum Rate Traffic, and

20 Guaranteed Rate Traffic, and wherein the first quality of service type has more stringent requirements for delay, jitter and loss than the second quality of service type.

55. A micro-flow wrapper logical unit as recited in claim 54, wherein the predefined label switched path is utilized by fewer data packets than other label switched paths in the set of predefined label switched paths.

5 56. A router, comprising:

storage for defining a set of label switched paths, each path having a particular quality of service that is adjusted based on utilization, the adjusting being independently calculated for each label switched path;

10 an internal routing fabric capable of internally routing a micro-flow, wherein the micro-flow comprises a set of data packets, and wherein the micro-flow has a quality of service type;

an ingress line card having logic that selects a particular label switched path from the defined set of label switched paths, the particular label switched path being selected based on the quality of service type of the micro-flow; and

15 an egress line card capable of transmitting the micro-flow along the selected label switched path.

57. A method for transmitting a data flow over a network connection, comprising the operations of:

20 receiving a first aggregate flow comprising a plurality of individual data flows at an ingress line card, each individual data flow comprising a plurality of data packets;

separating the first aggregate flow into a plurality of individual micro-flows at the ingress line card, each individual micro-flow comprising a data flow;

routing the micro-flows to an egress line card, the egress line card being selected based on a quality of service of each individual micro-flow;

5 assembling the plurality of individual micro-flows into a second aggregate flow having a quality of service capable of supporting the quality of service of the plurality of micro-flows, the assembling being performed at the egress line card; and

transmitting the second aggregate flow over the network connection.

10 58. A method for transmitting a data flow over a network connection as recited in claim 57, wherein the first aggregate flow is a label switched path and the second aggregate flow is another label switched path.

15 59. A method for transmitting a data flow over a network connection as recited in claim 58, further comprising the operation of determining a destination set of label switched paths capable of providing access to a destination address of the micro-flow.

20 60. A method for efficiently transmitting an aggregate micro-flow over a selected label switch path based on active analysis of quality of service parameters for a set of label switched paths, each label switched path having a dynamically changing quality of service, the method comprising:

(a) receiving a data-flow including a set of data packets;

(b) forming a micro-flow from the data-flow, the micro-flow having a quality of service type that includes transmission rate information;

(c) at a particular time, determining the quality of service supportable each of the

5 label switched paths;

(d) selecting a particular label switched path from the defined set of label switched paths based on the quality of service type of the micro-flow, wherein the quality of service supportable by the particular label switched path is not less than quality of service type of the micro-flow;

10 (e) transmitting the micro-flow along the selected label switched path; and

 (f) repeating (a)-(e) for any additional received data-flows.

61. A method for transmitting a received multiple label switched path-based aggregate micro-flow over a selected label switch path based on active analysis of quality of service parameters for a set of label switched paths, each label switched path having a dynamically changing quality of service, the method comprising:

(a) receiving a data-flow including a set of data packets;

(b) forming a micro-flow from the data-flow, the micro-flow having a quality of service type that includes transmission rate information;

15 (c) at a particular time, determining the quality of service supportable each of the label switched paths;

(d) selecting a particular label switched path from the defined set of label switched paths based on the quality of service type of the micro-flow, wherein the quality of service supportable by the particular label switched path is not less than quality of service type of the micro-flow;

5 (e) transmitting the micro-flow along the selected label switched path; and

 (f) repeating (a)-(e) for any additional received data-flows.